The slope 1032.6 indicates that tuition and fees have increased approximately $1033 per year.

(c) The year 2025 is too far in the future to rely on this equation to predict costs; too many other factors may influence these costs by then.

### 1.2 Linear Functions and Applications

1. \( f(2) = 7 - 5(2) = 7 - 10 = -3 \)
2. \( f(4) = 7 - 5(4) = 7 - 20 = -13 \)
3. \( f(-3) = 7 - 5(-3) = 7 + 15 = 22 \)
4. \( f(-1) = 7 - 5(-1) = 7 + 5 = 12 \)
5. \( g(1.5) = 2(1.5) - 3 = 3 - 3 = 0 \)
6. \( g(2.5) = (2.5) - 3 = 5 - 3 = 2 \)
7. \( g \left( \frac{1}{2} \right) = 2 \left( \frac{-1}{2} \right) - 3 = -1 - 3 = -4 \)
8. \( g \left( \frac{-3}{4} \right) = 2 \left( \frac{-3}{4} \right) - 3 = \frac{-3}{2} - 3 = -\frac{9}{2} \)
9. \( f(t) = 7 - 5(t) = 7 - 5t \)
10. \( g(k^2) = 2(k^2) - 3 = 2k^2 - 3 \)

11. This statement is true.
   When we solve \( y = f(x) = 0 \), we are finding the value of \( x \) when \( y = 0 \), which is the \( x \)-intercept.
   When we evaluate \( f(0) \), we are finding the value of \( y \) when \( x = 0 \), which is the \( y \)-intercept.

12. This statement is false.
   The graph of \( f(x) = -5 \) is a horizontal line.

13. This statement is true.
   Only a vertical line has an undefined slope, but a vertical line is not the graph of a function. Therefore, the slope of a linear function cannot be defined.

14. This statement is true.
   For any value of \( a \),
   \[
   f(0) = a \cdot 0 = 0,
   \]
   so the point \((0,0)\), which is the origin, lies on the line.

15. The fixed cost is constant for a particular product and does not change as more items are made. The marginal cost is the rate of change of cost at a specific level of production and is equal to the slope of the cost function at that specific value; it approximates the cost of producing one additional item.

19. $10 is the fixed cost and $2.25 is the cost per hour.

   Let \( x = \) number of hours;
   \( R(x) = \) cost of renting a snowboard for \( x \) hours.

   Thus,
   \[
   R(x) = \text{fixed cost} + (\text{cost per hour}) \cdot (\text{number of hours})
   \]
   \[
   R(x) = 10 + (2.25)(x)
   \]
   \[
   R(x) = 2.25x + 10
   \]

20. $10 is the fixed cost and $0.99 is the cost per downloaded song—the marginal cost.

   Let \( x = \) the number of downloaded songs and
   \( C(x) = \) cost of downloading \( x \) songs.

   Then,
   \[
   C(x) = (\text{marginal cost}) \cdot (\text{number of downloaded songs}) + \text{fixed cost}
   \]
   \[
   C(x) = 0.99x + 10.
   \]

21. $10 is the fixed cost and $35 is the cost per half-hour.

   Let \( x = \) the number of half-hours;
   \( C(x) = \) the cost of parking a car for \( x \) half-hours.

   Thus,
   \[
   C(x) = 50 + 35x
   \]
   \[
   C(x) = 35x + 50.
   \]

22. $44 is the fixed cost and $0.28 is the cost per mile.

   Let \( x = \) the number of miles;
   \( R(x) = \) the cost of renting for \( x \) miles.

   Thus,
   \[
   R(x) = \text{fixed cost} + (\text{cost per mile}) \cdot (\text{number of miles})
   \]
   \[
   R(x) = 44 + 0.28x.
   \]
23. Fixed cost, $100; 50 items cost $1600 to produce.

Let \( C(x) \) = cost of producing \( x \) items.

\( C(x) = mx + b \), where \( b \) is the fixed cost.

\[ C(x) = mx + 100 \]

Now, \( C(x) = 1600 \) when \( x = 50 \), so

\[ 1600 = m(50) + 100 \]
\[ 1500 = 50m \]
\[ 30 = m \]

Thus, \( C(x) = 30x + 100 \).

24. Fixed cost: $35; 8 items cost $395.

Let \( C(x) \) = cost of \( x \) items

\( C(x) = mx + b \), where \( b \) is the fixed cost

\[ C(x) = mx + 35 \]

Now, \( C(x) = 395 \) when \( x = 8 \), so

\[ 395 = m(8) + 35 \]
\[ 360 = 8m \]
\[ 45 = m \]

Thus, \( C(x) = 45x + 35 \).

25. Marginal cost: $75; 50 items cost $4300.

\[ C(x) = 75x + b \]

Now, \( C(x) = 4300 \) when \( x = 50 \).

\[ 4300 = 75(50) + b \]
\[ 4300 = 3750 + b \]
\[ 550 = b \]

Thus, \( C(x) = 75x + 550 \).

26. Marginal cost, $120; 700 items cost $96,500 to produce.

\[ C(x) = 120x + b \]

Now, \( C(x) = 96,500 \) when \( x = 700 \).

\[ 96,500 = 120(700) + b \]
\[ 96,500 = 84,000 + b \]
\[ 12,500 = b \]

Thus, \( C(x) = 120x+12,500 \).

27. \[ D(q) = 16 - 1.25q \]

(a) \( D(0) = 16 - 1.25(0) = 16 - 0 = 16 \)

When 0 watches are demanded, the price is $16.

(b) \( D(4) = 16 - 1.25(4) = 16 - 5 = 11 \)

When 400 watches are demanded, the price is $11.

(c) \( D(8) = 16 - 1.25(8) = 16 - 10 = 6 \)

When 800 watches are demanded, the price is $6.

(d) Let \( D(q) = 8 \). Find \( q \).

\[ \frac{8}{5} = 16 - 1.25q \]
\[ \frac{8}{5}q = 8 \]
\[ q = 6.4 \]

When the price is $8, 640 watches are demanded.

(e) Let \( D(q) = 10 \). Find \( q \).

\[ \frac{10}{5} = 16 - 1.25q \]
\[ \frac{5}{4}q = 6 \]
\[ q = 4.8 \]

When the price is $10, 480 watches are demanded.

(f) Let \( D(q) = 12 \). Find \( q \).

\[ \frac{12}{5} = 16 - 1.25q \]
\[ \frac{5}{4}q = 4 \]
\[ q = 3.2 \]

When the price is $12, 320 watches are demanded.

(h) \( S(q) = 0.75q \)

Let \( S(q) = 0 \). Find \( q \).

\[ 0 = 0.75q \]
\[ 0 = q \]

When the price is $0, 0 watches are supplied.
(i) Let \( S(q) = 10 \). Find \( q \).

\[
10 = 0.75q \\
\frac{40}{3} = q \\
q = 13.3
\]

When the price is $10, about 1333 watches are supplied.

(j) Let \( S(q) = 20 \). Find \( q \).

\[
20 = 0.75q \\
\frac{80}{3} = q \\
q = 26.6
\]

When the price is $20, about 2667 watches are demanded.

(k)

![Graph](image)

(l) \( D(q) = S(q) \)

\[
16 - 1.25q = 0.75q \\
16 = 2q \\
8 = q \\
S(8) = 0.75(8) = 6
\]

The equilibrium quantity is 800 watches, and the equilibrium price is $6.

28. \( D(q) = 5 - 0.25q \)

(a) \( D(0) = 5 - 0.25(0) = 5 - 0 = 5 \)

When 0 quarts are demanded, the price is $5.

(b) \( D(4) = 5 - 0.25(4) = 5 - 1 = 4 \)

When 400 quarts are demanded, the price is $4.

(c) \( D(8.4) = 5 - 0.25(8.4) = 5 - 2.1 = 2.9 \)

When 840 quarts are demanded, the price is $2.90.

(d) Let \( D(q) = 4.5 \). Find \( q \).

\[
4.5 = 5 - 0.25q \\
0.25q = 0.5 \\
q = 2
\]

When the price is $4.50, 200 quarts are demanded.

(e) Let \( D(q) = 3.25 \). Find \( q \).

\[
3.25 = 5 - 0.25q \\
0.25q = 1.75 \\
q = 7
\]

When the price is $3.25, 700 quarts are demanded.

(f) Let \( D(q) = 2.4 \). Find \( q \).

\[
2.4 = 5 - 0.25q \\
0.25q = 2.6 \\
q = 10.4
\]

When the price is $2.40, 1040 quarts are demanded.

(g)

![Graph](image)

(h) \( S(q) = 0.25q \)

Let \( S(q) = 0 \). Find \( q \).

\[
0 = 0.25q \\
q = 0
\]

When the price is $0, 0 quarts are supplied.

(i) Let \( S(q) = 2 \). Find \( q \).

\[
2 = 0.25q \\
q = 8
\]

When the price is $2, 800 quarts are supplied.

(j) Let \( S(q) = 4.5 \). Find \( q \).

\[
4.5 = 0.25q \\
q = 18
\]

When the price is $4.50, 1800 quarts are supplied.
Section 1.2 Linear Functions and Applications

(k) \[ D(q) = S(q) \]
\[ 4 - 0.25q = 0.25q \]
\[ 4 = 0.5q \]
\[ q = 8 \]
\[ S(8) = 0.25(8) = 2.0 \]

The equilibrium quantity is 8 quarts and the equilibrium price is $2.00.

(l) \[ D(q) = S(q) \]
\[ 5 - 0.25q = 0.25q \]
\[ 5 = 0.5q \]
\[ q = 10 \]
\[ S(10) = 0.25(10) = 2.5 \]

The equilibrium quantity is 1000 quarts and the equilibrium price is $2.50.

29. \[ D(q) = S(q) = \frac{2}{5}q; \]
\[ p = D(q) = 100 - \frac{2}{5}q \]

(a) \[ S(q) = D(q) \]
\[ \frac{2}{5}q = 100 - \frac{2}{5}q \]
\[ \frac{4}{5}q = 100 \]
\[ q = 125 \]
\[ S(125) = \frac{2}{5}(125) = 50 \]

The equilibrium quantity is 125, the equilibrium price is $50.

30. (a) \[ S(q) = D(q) \]
\[ p = 1.4q - 0.6 \]
\[ p = -2q + 3.2 \]

Set supply equal to demand and solve for \( q \).
\[ 1.4q - 0.6 = -2q + 3.2 \]
\[ 1.4q + 2q = 0.6 + 3.2 \]
\[ 3.4q = 3.8 \]
\[ q = \frac{3.8}{3.4} \]
\[ q \approx 1.12 \]
\[ S(1.12) = 1.4(1.12) - 0.6 \]
\[ = 0.96 \]

The equilibrium quantity is about 120 pounds; the equilibrium price is about $0.96.

(b) \[ S(q) = p = 1.4q - 0.6 \]
\[ D(q) = p = -2q + 3.2 \]

Set supply equal to demand and solve for \( q \).
\[ 1.4q - 0.6 = -2q + 3.2 \]
\[ 1.4q + 2q = 0.6 + 3.2 \]
\[ 3.4q = 3.8 \]
\[ q = \frac{3.8}{3.4} \]
\[ q \approx 1.12 \]
\[ S(1.12) = 1.4(1.12) - 0.6 \]
\[ = 0.96 \]

The equilibrium quantity is about 1120 pounds; the equilibrium price is about $0.96.

31. (a) \[ C(x) = mx + b; \]
\[ m = 3.50; \]
\[ C(60) = 300 \]
\[ C(x) = 3.50x + b \]

Find \( b \).
\[ 300 = 3.50(60) + b \]
\[ 300 = 210 + b \]
\[ 90 = b \]
\[ C(x) = 3.50x + 90 \]

(b) \[ R(x) = 9x \]
\[ C(x) = R(x) \]
\[ 3.50x + 90 = 9x \]
\[ 90 = 5.5x \]
\[ 16.36 = x \]

Joanne must produce and sell 17 shirts.

(c) \[ P(x) = R(x) - C(x); \]
\[ P(x) = 500 \]
\[ 500 = 9x - (3.50x + 90) \]
\[ 500 = 5.5x - 90 \]
\[ 590 = 5.5x \]
\[ 107.27 = x \]

To make a profit of $500, Joanne must produce and sell 180 shirts.
32. (a) \( C(x) = mx + b \)
\( C(1000) = 2675; \ b = 525 \)
Find \( m \).
\[
2675 = m(1000) + 525
\]
\[
2150 = 1000m
\]
\[
2.15 = m
\]
\[
C(x) = 2.15x + 525
\]
(b) \( R(x) = 4.95x \)
\( C(x) = R(x) \)
\[
2.15x + 525 = 4.95x
\]
\[
525 = 2.80x
\]
\[
187.5 = x
\]
In order to break even, he must produce and sell 188 books.
(c) \( P(x) = R(x) - C(x); \ P(x) = 1000 \)
\[
1000 = 4.95x - (2.15x + 525)
\]
\[
1000 = 4.95x - 2.15x - 525
\]
\[
1525 = 2.80x
\]
\[
544.6 = x
\]
In order to make a profit of $1000, he must produce and sell 545 books.

33. (a) Using the points \( (100, 11.02) \) and \( (400, 40.12) \),
\[
m = \frac{40.12 - 11.02}{400 - 100} = \frac{29.1}{300} = 0.097.
\]
\[
y - 11.02 = 0.097(x - 100)
\]
\[
y - 11.02 = 0.097x - 9.7
\]
\[
y = 0.097x + 1.32
\]
\[
C(x) = 0.097x + 1.32
\]
(b) The fixed cost is given by the constant in \( C(x) \). It is $1.32.
(c) \( C(1000) = 0.097(1000) + 1.32 = 97 + 1.32 = 98.32 \)
The total cost of producing 1000 cups is $98.32.
(d) \( C(1001) = 0.097(1001) + 1.32 = 97.097 + 1.32 = 98.417 \)
The total cost of producing 1001 cups is $98.417.
(e) Marginal cost = $98.417 - 98.32 = $0.097 or 9.7¢
(f) The marginal cost for any cup is the slope, $0.097 or 9.7¢. This means the cost of producing one additional cup of coffee would be 9.7¢.

34. \( C(10,000) = 547,500; \ C(50,000) = 737,500 \)
(a) \( C(x) = mx + b \)
\[
m = \frac{737,500 - 547,500}{50,000 - 10,000} = \frac{190,000}{40,000} = 4.75
\]
\[
y - 547,500 = 4.75(x - 10,000)
\]
\[
y - 547,500 = 4.75x - 47,500
\]
\[
y = 4.75x + 500,000
\]
\[
C(x) = 4.75x + 500,000
\]
(b) The fixed cost is $500,000.
(c) \( C(100,000) = 4.75(100,000) + 500,000 = 475,000 + 500,000 = 975,000 \)
The total cost to produce 100,000 items is $975,000.
(d) Since the slope of the cost function is 4.75, the marginal cost is $4.75. This means that the cost of producing one additional item at this production level is $4.75.

35. (a) \( (100,000)(50) = 5,000,000 \)
Sales in 1996 would be 100,000 + 5,000,000 = 5,100,000.
(b) The ordered pairs are \( (1, 100,000) \) and \( (6, 5,100,000) \).
\[
m = \frac{5,100,000 - 100,000}{6 - 1} = \frac{5,000,000}{5} = 1,000,000
\]
\[
y - 100,000 = 1,000,000(x - 1)
\]
\[
y - 100,000 = 1,000,000x - 1,000,000
\]
\[
y = 1,000,000x - 900,000
\]
\[
S(x) = 1,000,000x - 900,000
\]
(c) Let \( S(x) = 1,000,000,000 \). Find \( x \).
\[
1,000,000,000 = 1,000,000x - 900,000
\]
\[
1,000,000,000 = 1,000,000x
\]
\[
x = 1000.9
\]
Sales would reach $1 billion in about 1991 + 1000.9 = 2991.9, or during the year 2991.
Sales would have to grow much faster than linearly to reach $1 billion by 2003.
Section 1.2 Linear Functions and Applications

(d) Use ordered pairs (13, 356,000,000) and (14, 479,000,000).

\[ m = \frac{479,000,000 - 356,000,000}{14 - 13} = 123,000,000 \]

\[ S(x) - 356,000,000 = 123,000,000(x - 13) \]
\[ S(x) - 356,000,000,000 = 123,000,000x - 1,599,000,000 \]
\[ S(x) = 123,000,000x - 1,243,000,000 \]

(e) The year 2005 corresponds to \( x = 2005 - 1990 = 15 \).

\[ S(15) = 123,000,000(15) - 1,243,000,000 \]
\[ S(15) = 602,000,000 \]

The estimated sales are $602,000,000, which is less than the actual sales.

(f) Let \( S(x) = 1,000,000,000 \). Find \( x \).

\[ 1,000,000,000 = 123,000,000x - 1,243,000,000 \]
\[ 2,243,000,000 = 123,000,000x \]
\[ x \approx 18.2 \]

Sales would reach $1 billion in about 1990 + 18.2 = 2008.2, or during the year 2009.

36. \( C(x) = 5x + 20; R(x) = 15x \)

(a) \( C(x) = R(x) \)
\[ 5x + 20 = 15x \]
\[ 20 = 10x \]
\[ x = 2 \]

The break-even quantity is 2 units.

(b) \( P(x) = R(x) - C(x) \)
\[ P(x) = 15x - (5x + 20) \]
\[ P(100) = 15(100) - (5 \cdot 100 + 20) \]
\[ = 1500 - 520 = 980 \]

The profit from 100 units is $980.

(c) \( P(x) = 500 \)
\[ 15x - (5x + 20) = 500 \]
\[ 10x - 20 = 500 \]
\[ 10x = 520 \]
\[ x = 52 \]

For a profit of $500, 52 units must be produced.

37. \( C(x) = 12x + 39; R(x) = 25x \)

(a) \( C(x) = R(x) \)
\[ 12x + 39 = 25x \]
\[ 39 = 13x \]
\[ x = 3 \]

The break-even quantity is 3 units.

(b) \( P(x) = R(x) - C(x) \)
\[ P(x) = 25x - (12x + 39) \]
\[ P(x) = 13x - 39 \]
\[ P(250) = 13(250) - 39 \]
\[ = 3250 - 39 \]
\[ = 3211 \]

The profit from 250 units is $3211.

(c) \( P(x) = $130; find x \).
\[ 130 = 13x - 39 \]
\[ 169 = 13x \]
\[ 13 = x \]

For a profit of $130, 13 units must be produced.

38. \( C(x) = 85x + 900 \)
\( R(x) = 105x \)

Set \( C(x) = R(x) \) to find the break-even quantity.
\[ 85x + 900 = 105x \]
\[ 900 = 20x \]
\[ 45 = x \]

The break-even quantity is 45 units. You should decide not to produce since no more than 38 units can be sold.

\[ P(x) = R(x) - C(x) = 105x - (85x + 900) \]
\[ = 20x - 900 \]

The profit function is \( P(x) = 20x - 900 \).

39. \( C(x) = 105x + 6000 \)
\( R(x) = 250x \)

Set \( C(x) = R(x) \) to find the break-even quantity.
\[ 105x + 6000 = 250x \]
\[ 6000 = 145x \]
\[ 41.38 \approx x \]

The break-even quantity is about 41 units, so you should decide to produce.

\[ P(x) = R(x) - C(x) \]
\[ = 250x - (105x + 6000) \]
\[ = 145x - 6000 \]

The profit function is \( P(x) = 145x - 6000 \).
**40.** \(C(x) = 70x + 500\)
\[R(x) = 60x\]

\[70x + 500 = 60x\]
\[10x = -500\]
\[x = -50\]

This represents a break-even quantity of \(-50\) units. It is impossible to make a profit when the break-even quantity is negative. Cost will always be greater than revenue.

\[P(x) = R(x) - C(x) = 60x - (70x + 500)\]
\[= -10x - 500\]

The profit function is \(P(x) = -10x - 500\).

**41.** \(C(x) = 1000x + 5000\)
\[R(x) = 900x\]

\[900x = 1000x + 5000\]
\[-5000 = 100x\]
\[-50 = x\]

It is impossible to make a profit when the break-even quantity is negative. Cost will always be greater than revenue.

\[P(x) = R(x) - C(x) = 900x - (1000x + 5000)\]
\[= -100x - 5000\]

The profit function is \(P(x) = -100x - 5000\) (always a loss).

**42.** Use the formulas derived in Example 7 in this section of the textbook.

\[F = \frac{9}{5}C + 32\]
\[C = \frac{5}{9}(F - 32)\]

(a) \(F = 58;\) find \(C\).

\[C = \frac{5}{9}(58 - 32)\]
\[C = \frac{5}{9}(26)\]
\[C = 14.4\]

The temperature is 14.4°C.

(b) \(F = -20;\) find \(C\).

\[C = \frac{5}{9}(F - 32)\]
\[C = \frac{5}{9}(-20 - 32)\]
\[C = \frac{5}{9}(-52)\]
\[C = -28.9\]

The temperature is -28.9°C.

(c) \(C = 50;\) find \(F\).

\[F = \frac{9}{5}C + 32\]
\[F = \frac{9}{5}(50) + 32\]
\[F = 90 + 32\]
\[F = 122\]

The temperature is 122°F.

**43.** Use the formula derived in Example 7 in this section of the textbook.

\[F = \frac{9}{5}C + 32\]
\[C = \frac{5}{9}(F - 32)\]

(a) \(C = 37;\) find \(F\).

\[F = \frac{9}{5}(37) + 32\]
\[F = \frac{333}{5} + 32\]
\[F = 65.7 + 32\]
\[F = 98.6\]

The Fahrenheit equivalent of 37°C is 98.6°F.

(b) \(C = 36.5;\) find \(F\).

\[F = \frac{9}{5}(36.5) + 32\]
\[F = 65.7 + 32\]
\[F = 97.7\]

\[C = 37.5;\) find \(F\).

\[F = \frac{9}{5}(37.5) + 32\]
\[F = 70 + 32\]
\[F = 102\]

\[C = 38;\) find \(F\).

\[F = \frac{9}{5}(38) + 32\]
\[F = 68 + 32\]
\[F = 100\]

The range is between 97.7°F and 99.5°F.
44. If the temperatures are numerically equal, then \( F = C \).
\[
F = \frac{9}{5} C + 32
\]
\[
C = \frac{9}{5} C + 32
\]
\[
\frac{4}{5} C = 32
\]
\[
C = -40
\]
The Celsius and Fahrenheit temperatures are numerically equal at \(-40^\circ\).

### 1.3 The Least Squares Line

2. For the set of points \((1, 4), (2, 5),\) and \((3, 6),\) \(Y = x + 3.\) For the set \((4, 1), (5, 2),\) and \((6, 3),\) \(Y = x - 3.\)

3. (a)

(b) | \(x\) | \(y\) | \(xy\) | \(x^2\) | \(y^2\) |
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<tr>
<td>55</td>
<td>25.5</td>
<td>186</td>
<td>385</td>
<td>90.75</td>
</tr>
</tbody>
</table>

\[
r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{n(\sum x^2) - (\sum x)^2} \cdot \sqrt{n(\sum y^2) - (\sum y)^2}}
= \frac{10(186) - (55)(25.5)}{\sqrt{10(385) - (55)^2} \sqrt{10(90.75) - (25.5)^2}}
\approx 0.993
\]

(c) The least squares line is of the form \(Y = mx + b.\) First solve for \(m.\)
\[
m = \frac{n(\sum xy) - (\sum x)(\sum y)}{n(\sum x^2) - (\sum x)^2}
= \frac{10(186) - (55)(25.5)}{10(385) - (55)^2}
= 0.5545454545 \approx 0.55
\]

Now find \(b.\)
\[
b = \frac{\sum y - m(\sum x)}{n}
= \frac{25.5 - 0.55(55)}{10}
= -0.5
\]

Thus, \(Y = 0.55x - 0.5.\)

4. (d) Let \(x = 11.\) Find \(Y.\)
\[
Y = 0.55(11) - 0.5 = 5.55
\]

4. (c) The least squares line is of the form \(Y = mx + b.\) First solve for \(m.\)
\[
m = \frac{n(\sum xy) - (\sum x)(\sum y)}{n(\sum x^2) - (\sum x)^2}
= \frac{10(37.81) - (35.5)(5.3)}{\sqrt{5(252.25) - (35.5)^2} \cdot \sqrt{5(5.95) - (5.3)^2}}
\approx 0.6985
\]

\[
r^2 = (0.6985)^2 \approx 0.5
\]

The answer is choice (c).